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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/292,186	04/15/1999	DANIEL M. KINZER	IR-1609-(2-1	3190

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EXAMINER	
HU, SHOUXIANG	
ART UNIT	PAPER NUMBER
2811	

SHORTENED STATUTORY PERIOD OF RESPONSE	MAIL DATE	DELIVERY MODE
3 MONTHS	01/31/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

If NO period for reply is specified above, the maximum statutory period will apply and will expire 6 MONTHS from the mailing date of this communication.

Office Action Summary	Application No.	Applicant(s)	
	09/292,186	KINZER, DANIEL M.	
	Examiner	Art Unit	
	Shouxiang Hu	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 October 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3-6,8-13 and 20-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-6,8-13 and 20-23* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

Claims 1, 3-6, 8-13 and 20-23 are objected to because of the following informalities and/or defect:

Claims 1, 4 and 9 each recite the subject matter that the channel material/layer has a constant (or substantially constant) concentration, but fail to clarify what type of dopant(s) the recited concentration refers to.

In claim 1, the term of "gate contact" should read as: --gate--, as gate contact normally refers to an electrode that contacts a gate in the art.

Claim 1 recites the subject matters of "said vertical invertible channel material having a constant concentration along its full length"; but, it fails to clearly define what is the full length of the channel material, given that least the edge portions of the channel material layer have non-uniform doping concentrations, due to dopant diffusion effect that naturally exists during the epitaxial growth of the channel material layer in the instant invention.

Claims 4 and 8 recite the subject matters of "reduced on resistance", but fail to clarify what type of device(s) is compared with so as to have the recited reduced on resistance.

Claims 20-22 recites the subject matter of a highly doped region within the channel material/layer, which appears to contradict to what is recited in claims 1, 4 and

9, in which the channel material/layer is already defined as having a constant concentration.

Appropriate correction is required.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1, 3-6, 8-13 and 20-22, as being best understood in view of the claim objections above, are rejected under 35 U.S.C. 103(a) as being unpatentable over Floyd'716 (Floyd et al., US 6,090,716) in view of Love (US 4,516,143) and/or Bulucea (Bulucea et al., US 5,701,023).

Floyd'716 discloses a trench-type power MOSFET device (particularly see Fig. 10, and col. 2, lines 22-67), comprising: a vertical invertible channel composed of a first conductivity type (52; p type) between a heavily doped source region of a second conductivity type (50; n type) and a heavily doped drain region (or drain layer) of the second conductivity type (54; n type); a gate oxide (56); polysilicon trench gates of the second conductivity type (58A; n type), a source contact (66) in contact with the source region, wherein the layer of the channel material (i.e., a channel layer, a body layer/region, or, a channel-forming layer) is an epitaxial layer and has a substantially constant concentration along its full length (see Fig. 11).

In the embodiment of Fig. 10 in Floyd'716, the MOSFET device is an n-channel MOSFET (which normally has a source-channel-drain doping polarity of an n-p-n polarity type, i.e., with the first conductivity type being a p type and the second conductivity type being an n type). Although Floyd does not expressly disclose that the MOSFET device can also be a p-channel MOSFET (which normally has a p-n-p doping polarity), the examiner notes that it is well known in the art that: a MOSFET can be either an n-channel MOSFET or a p-channel MOSFET; a MOSFET design/structure which works under one polarity type is normally also workable under the reversed polarity; and, the p-n-p doping polarity type MOSFET (i.e., the p-channel type MOSFET) is desirable in various applications in the art.

Support for the above examiner's note can be readily found in the prior art, such as the following prior art references provided by the examiner: Floyd'043 (Floyd et al., US 6,069,043; see Figs. 3 and 11, and col. 7, lines 11-17) and Darwish'766 (Darwish et al., US 5,674,766; see col. 11, lines 20-22). And, the desirability for the p-n-p doping polarity type MOSFET (p-channel MOSFET) can be further supported by applicant's admitted prior art in the instant disclosure (see the p-n-p doping polarity type MOSFET in Fig. 1).

Therefore, it would have been well within the ordinary skilled in the art at the time the invention was made to make the MOSFET device of Floyd'716 with the doping polarity being reversed, so that a MOSFET with desired p-channel type and/or improved circuit design flexibility (associated with the desired channel type) would be achieved.

Furthermore, although Floyd'716 does not expressly disclose that the MOSFET can further include a drain contact made of metal, the examiner further notes that it is well known in the art that either of metal and polysilicon can be used to form a drain contact (Support for such further note can be found in Buchanan (US 4,333,224, see the abstract, which is provided here for the convenience of the applicant). And, one of the ordinary skill in the art would readily recognize that the drain contact can be commonly formed of a metal for reducing the contact resistance (given the well-known fact that metal normally can have lower contact resistance compared with polysilicon) and/or for improving flexibility on material choices for the drain contact, as evidenced in Love (see the metal drain contact 105 in Figs. 8, 9 and 11) and/or in Bulucea (see the drain contact 50 in Figs. 7 and 24)

Therefore, it would also have been well within the ordinary skilled in the art at the time the invention was made to further incorporate a metal drain contact such as the one of Love and/or the one of Bulucea into the above doping-polarity-reversed MOSFET device, so that a p-channel MOSFET with reduced contact resistance and/or with improved material choices/flexibility for the drain contact would be obtained, as such drain contact metal material is an art-known material that is well suited for the intended use. The selection of a known material based on its suitability for its intended use supported a prima facie obviousness determination in *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945).

Regarding claim 3, it is noted that silicon is the most widely used semiconductor material.

Regarding claims 4-6, 8-13, 21 and 22, the MOSFET device of Floyd with reversed polarity would inherently have a reduced on-resistance (when compared to the conventional p-channel MOSFET such as the one shown in Fig. 1 of the instant disclosure; the same type of comparison made in the instant disclosure, see the tables on pages 3 and 4 in the specification) and can be bidirectional, as it would be basically identical to the structure of the instant invention and would not have any lightly doped drift layer between the channel-forming layer and the heavily doped drain layer.

Regarding claims 8, 11-13, although the above collectively taught device does not expressly disclose that the channel layer can have a resistivity of about 0.17 Ohm-cm and a thickness of about 2.5 um, and that the substrate has a resistivity less than 0.0005 Ohm-cm, it noted that these values are respectively well within the commonly recognized ranges for the relevant parameters, and that it is old and well known in the art the threshold voltage and the on resistance of MOSFET are directly correlated to the doping concentrations of the channel layer and the substrate layer and the thickness of the channel layer; and they are all well recognized parameters of importance subject to routine experimentation and optimization.

Therefore, it would have been obvious to one of ordinary skilled in the art at the time the invention was made to make the above collectively taught MOSFET device (with the doping polarity being p-n-p type), with the channel layer having a resistivity of about 0.17 Ohm-cm and a thickness of about 2.5 um and with the substrate having a resistivity less than 0.0005 Ohm-cm, through routine experimentation and optimization

within the commonly recognized ranges for those parameters, so that a p-channel MOSFET with the desired threshold voltage and on-resistance would be achieved.

Regarding claims 6 and 10, it is further noted that it is well known in the art that it is desirable to have a source electrode in direct contact with the source region and also with the top region of the channel-forming layer (or, base layer/region) via notches extending through the source region, for improving the device stability by preventing the potential parasitic bipolar transistor therein from turning on, as further evidenced in Love (see the notches 104 and/or 106 in Figs. 10 and 11). Therefore, it would also have been obvious to one of ordinary skilled in the art at the time the invention was made to further incorporate the notch structure of Love into the above collectively taught device, so that a MOSFET device with improved stability would be obtained.

Regarding claims 20-21, it is further noted that it is well known in the art that it is desirable to form heavily doped region(s) in the channel-forming layer (or the base region) for improving the device stability by preventing the potential parasitic bipolar transistor therein from turning on and/or by improving the ruggedness under drain advance conditions, as further evidenced in Bulucea (see the heavily doped regions 250 and/or 310 in Figs. 7, 19, 24 and 24). Therefore, it would also have been obvious to one of ordinary skilled in the art at the time the invention was made to further incorporate the heavily doped base regions of Bulucea into the above collectively taught device, so that a MOSFET device with improved stability would be obtained.

Response to Arguments

Applicant's arguments with respect to the above rejected claims have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Reference C is cited as being related to a drain-contact material.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Shouxiang Hu whose telephone number is 571-272-1654. The examiner can normally be reached on Monday through Friday, 8:30 AM to 5:00 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richard T. Elms can be reached on 571-272-1869. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a

USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

SH
January 17, 2007

SHOUXIANG HU
PRIMARY EXAMINER